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(54) IMPROVEMENTS IN OR RELATING TO A SYSTEM FOR MOORING A VESSEL, PARTICULARLY AN OIL-TANKER, TO AN OFF-SHORE TOWER

(71) We, ENTREPRISE D'EQUIPEMENTS MECANIQUES ET HYDRAULIQUES E.M.H., a French Body Corporate of 29, rue de l'Abreuvoir—92100 Boulogne Billancourt, France, do hereby declare the invention,

for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a system for mooring a ship or like floating vessel, particularly an oil-tanker, to an off-short tower or column, e.g. a tower or column fixedly or pivotally mounted on a sea bed or ocean floor, and for transferring a fluid cargo such as petroleum oil or the like.

It is known to place on the tower or platform the major part of a system intended to ensure the connection between the upper end of the conduit or conduits of the tower, on the one hand, and the conduits of the vessel on the other hand. Such systems comprise particularly an arm carried by the platform, but it is always necessary to provide flexible connecting pipes between the free end of the arm and the conduits of the vessel.

The invention aims at providing in at least some embodiments an assembly which is entirely rigid, thus avoiding the agency of flexible pipes.

According to the invention, the systems of the kind in question comprise at least one arm pivotally carried by the tower, particularly by the rotating head of the latter, if any, the end of the said arm supporting, by means of a telescopic or extensible rigid device, a connector system adapted to be fitted onto a hollow mouth-piece or like fitting head mounted on the vessel and connected to the stationary conduit of the latter.

In such an assembly, any conduit between the platform and the vessel can be carried by the arm and its appended devices. In particular this conduit may comprise only rigid elements, possibly common to those of the said arm and to the said appended devices, particularly to the extensible or telescopic system.

Within this telescopic system the liquid can be made to pass in pipes which also are telescopic, or use can be made of an arrangement capable of being used independently, i.e. of being applied to any fluid connector system, whatever the general arrangement, in which arrangement the extensible system carried by the aforesaid arm is designed in the form of successive deformable elements constituting four-bar linkages, of the pantograph type, at least some of the said elements being hollow to serve as passages for the fluid, in combination with appropriate rotary joints.

It is understood that instead of a single arm there can be provided several arms interconnected by movable joints, with means provided at the said movable joints and controlled by servo-motors to open or close their mutual angle of incidence, this solution allowing the assembly to be collapsed, retracted or folded up on the tower during the period of rest.

The single arm, or the first arm from the tower, may be fixedly or pivotally assembled to the rotatable head of the tower in proximity to the vertical axis of the latter, or alternatively, it may be pivotally assembled to the end of a horizontal or inclined beam secured to the said tower or to its rotatable head if any.

As for the mooring proper it can be performed by means of a hawser, one end of which is attached for example to the aforesaid connector device, therefore to the vessel, once the said device is put in place for the transfer of the fluid, whereas its other end is attached to a winch or, preferably, to a balance- or counter-weight capable of being retracted together with a portion of the hawser into the tower.

As another possible alternative, the hawser can be done away with and use can be made of the arms, especially where several such arms are provided, to support the mooring strain once the connection is

performed, in combination with absorbing or damping means maintaining the assembly constituted by the arms and the connector in a predetermined relative position while at the same time allowing a certain resiliency to subsist in the connection.

It should be noted, in any case, that owing to the presence of extensible or telescopic devices, the structure as a whole, after the connection and the mooring, offers possibilities of deformations, preferably absorbed by the aforesaid absorbing or damping means, and can therefore withstand without danger the relative motions of the vessel and the tower under the action of the sea heave.

As for the connector device, it is advantageously obtained according to an arrangement described in patent application No. 41821/77 (Serial No. 1,591,645) filed at the same time as the present application in the name of ENTREPRISE D'EQUIPEMENTS MECANIQUES ET HYDRAULIQUES E.M.H., and in which a device is used comprising on the one hand a hollow body with a centring and guiding cone adapted to co-operate with the aforesaid mouthpiece or like fitting heat and, on the other hand, with a sliding connector element suitably operated to be engaged into the said mouth-piece and thus ensure the connection, in conjunction with packing or sealing means, and lastly locking means for maintaining the connecting position.

The operation of the various motors or servo-motors or actuators to ensure the necessary movements of the assembly carried by the tower, can be controlled either from the latter or from the vessel itself by radio transmission acting upon receiver relays associated with the said motors, the latter solution allowing tower personnel to be dispensed with or to be reduced to the necessary number for simple supervision or watching purposes.

Apart from the above arrangements, the invention comprises some other arrangements, which are used preferably at the same time and which will be referred to more clearly later.

The invention will be better understood and other purposes, features, details and advantages of the latter will appear more clearly from the following explanatory description made with reference to the appended diagrammatic drawings given solely by way of example illustrating one form of embodiment of the invention and wherein:

Figure 1 is a diagrammatic elevational view, with portions removed, of an assembly constituted by an oil-loading or storage tower or column, a vessel and a system for mooring the latter and transferring the oil, the whole assembly being designed according to the invention;

Figure 2 is a diagrammatic top view, to a larger scale, of certain elements of the extensible portion carrying the connector system comprised in the said assembly;

Figure 3 is a view similar to Figure 1, illustrating another form of embodiment of the invention.

An off-shore tower or column, for example a tower 1 (Figure 1), is connected to the sea bed or ocean floor either pivotally or not for receiving the oil through conduits or lines such as 5. The means for mooring a ship or like floating vessel 6 to allow the transfer (in one direction or other depending upon the purpose to be achieved) of oil between the conduit 5 and another conduit or line 7 secured to the vessel are provided as follows or in a similar manner.

Use is made essentially of at least one arm 8 which can be secured on the rotary head 9 of tower 1, where such a rotary head is provided, or pivotally assembled to the latter, the said arm being of suitable length to allow the connection to be performed when the bow of the vessel is located a suitable distance from the tower, the free end of the said arm supporting at 10, preferably through a universal or Cardan joint, a connector device C adapted to be fitted onto a hollow mouth-piece or fitting head 20 connected to the end of the fixed conduits of the vessel, the connection between the Cardan joint 10 and the said connector being ensured by rigid and extensible or telescopic means T (Figures 1 and 3) the length of which is therefore variable.

It is understood that several arms can be used, for example two arms 8_1 and 8_2, one (8_1) of the latter being pivotally assembled either to the head of the tower or, if suitable and as shown in Figure 3, to the end of a support beam or plate 51 rotating together with the said head, whereas the second arm (8_2) is hingedly assembled at 10^1 to arm 8_1.

It is also understood that if the tower is not provided with a rotary head, the arm 8 or 8_1 may be mounted on the tower stationary platform or top in swivelling relationship to the latter.

As for the conduit portions to be provided in this assembly between the platform, i.e. between the conduit 5, on the one hand, and the connector C, on the other hand, they may be constituted by rigid pipes carried by the structures of the said assembly, the said portions being for example telescopic or extensible within the extensible system T interconnecting the connector C and the arm 8 or 8_2 at 10.

However, as shown in the drawings, the said extensible means T may advantageously be constituted by a set or series of articu-

lated elements in the nature of pantographs or the like, at least some of the articulated elements, in the form of tubes, in combination with rotary joints, being used to ensure the passage of the liquid between the rotary joint 10 and the connector C.

There is shown in Figures 1 and 2 a form of embodiment of an extensible system of this kind, which comprises for example two series 11, 12 of rectilinear elements pivotally connected to one another around axes 13 and 14_1, 14_2 (to form rhombuses, some (13) of the said axes being located along a central line AA, on either side of which are located the axes 14_1, 14_2 forming the vertices of the rhombuses.

For the sake of simplification it is assumed in Figures 1 and 2 that only one series 11 of the elements is used to transfer the liquid and is constituted to this end by hollow elements, with corresponding rotary joints at 14_1, whereas the other series 12 is constituted by any connecting elements jointed at 14_2. It is understood, however, that both series of elements can be used to transfer the liquid.

The assembly of articulated elements is pivotally connected at 10 and 15 to the conduit carried by the arm 8 and to the inlet of connector C, respectively.

The actuation of this articulated system or its extension or its retraction can be performed in any appropriate manner, for example by means of a cable 32 passing round a pulley 33 and which is wound onto or unwound from a winch 34 operated by a motor 35.

As regards the connector C, it may be constructed as pointed out above, in the manner described in the aforementioned patent application filed at the same time as the present application, or in any other suitable manner.

Shown diagrammatically in Figure 1 are the essential elements of this connector, which comprises for example, in order to co-operate with a mouth-piece or fitting head 20 to which the conduit 7 of the vessel leads:

a hollow body 21 supported by a support pivotally connected to the base of the extensible system T (or directly to the arm 8 if such a system is not used) which hollow body can be fitted with an appropriate clearance onto the head 20 and is provided at its bottom with a centring cone 23;

a sliding hollow connector element hydraulically connected to the conduit proceeding from the tower or the extensible system T and operated by an actuator to sealingly engage into the outlet passage 24 of the head 20;

and locking means ensuring a stable connecting position, e.g. locking pins or the like adapted to co-operate with a slot 25 provided on the said head.

The assembly can be completed by television cameras 36 carried by the connector system T and allowing it to be readily located with respect to the vessel during manoeuvring operations.

The whole of this assembly carried by the tower is completed by means ensuring the mooring of the vessel once the connection is accomplished, the said means comprising for example a hawser 26 of the usual type, one end of which, according to an advantageous form of embodiment, can be attached to a ring 27 mounted freely around the body 21 of the connector system C, whereas the other end can be attached at a fixed point 52 of the tower (Figure 1) or to a winch or, preferably, after passing on a guiding pulley 28, to a counter- or balance-weight 29 hanging freely within the tower as shown in Figure 3.

It is also possible, if suitable, to dispense with the said hawser and to ensure the mooring by means of the rigid system constituted by the arm or arms such as 8, 8_1, 8_2 and by the connector C. It is sufficient, to this end, to fix this assembly after the connection while at the same time allowing for a certain deformation thereof, in combination with shock-absorbing or damping means.

The presence of such absorbing means is always useful since it allows the whole structure to follow, owing to the relative deformations of its various elements but without danger of resonance, the relative motions of the vessel (rolling, pitching) and of the oscillating of the tower under the action of the heave of the sea.

Thus, assuming that use is made, as shown in Figure 3, of two arms combined with a hawser 26 attached (by any suitable means after the mooring position is obtained) at one end to the connector and at the other end to the tower, and assuming also that the relative displacements of arms 8_1, 8_2 are performed for example by an actuator 31 placed between two pivot axes 30_1 and 30_2, the absorbing or damping effect can be ensured by an oleopneumatic device 38 connected to the said actuator and coming into action after the latter has moved both arms to the required position.

However, there can be provided for the same purpose a rigid locking of the articulated assembly and the mouth-piece or fitting head 20 can be constituted by a body connected to the vessel not rigidly as previously but through absorbing or damping means.

Consequently, a vessel mooring and cargo transferring assembly is obtained which allows all apparatus to be grouped on the platform, but without requiring the presence of flexible pipes, the said assembly being

simple to operate and, if suitable, controllable from the vessel (remote radio control). The assembly operates during the mooring as follows.

Considering for example the form of embodiment of Figure 1, with a hawser 26 connected to the connector system C, before the mooring, the latter together with the extensible device T is in retracted position and the arm 8 is oriented in the direction of the wind.

The vessel then manoeuvres, in particular by means of a bow thruster 37, so as to move closer to, and to assume a position in the vertical plane of, the corrector device C.

Thereafter the extensible system T is moved downwards by means of the motor 35, this operation being controlled either from the tower by a qualified personnel or preferably directly from the vessel if the latter is equipped with radio means capable of remotely acting on relays controlling the motor 35 as well as the other means of operation of the assembly.

Once this operation is over and the hollow body 21 of the connector device C is fitted on the mouth-piece 20 located on the vessel, the whole arrangement is locked by means of the locking pins co-operating with the slot 25.

The mooring is then ensured for example by the hawser 26 tensioned by the balance-weight 29 (Figure 3).

A similar procedure is used in the case of the assembly according to Figure 3, the extension of the said assembly being ensured by the actuator 31 and the motor 35.

Owing to this arrangement, the assembly can be easily moved to a space saving retracted idle position.

Lastly, if the platform is not provided with a rotary head, in which case the arm 8 or 8, is necessarily mounted directly on the tower and movable about a vertical pivot and possibly also about a horizontal axis, the operating steps still remain substantially the same, again allowing the presence of flexible connecting pipes to be avoided as much as possible.

In any case, the invention offers a great many advantages over the already existing equipments of the kind considered, particularly:

that of substantially using only elements that are rigid and easy to look after;

that of requiring simple operating steps, controlled from the vessel by radio means if suitable;

that of ensuring all the necessary accuracy of the said operating steps;

that of allowing, by folding the retractable device T and, in the case of two arms, by folding the latter, the whole assembly to be folded up so as to occupy minimum space;

That of allowing the relative displacements of the vessel and the tower to be easily followed in the mooring position, owing to the use of the said retractable device and, possibly, of movable joints between the arms in case several arms are used.

Of course, the invention is by no means limited to the form of embodiment described and illustrated which has been given by way of example only.

WHAT WE CLAIM IS:—

1. A system for mooring a ship or like floating vessel, particularly an oil-tanker, to an off-shore tower or column and for transferring a liquid or gaseous cargo such as, for example, gas, petroleum oil or the like, using an arm carried by the head of the tower and adapted to rotate about the latter, characterized in that it comprises at least one arm carried by the said head and an extensible or telescopic device pivotally coupled at one end to the free end of said arm so as to extend substantially vertically under the effect of gravity and carrying at its free lower end a connector device and moving said connector device along a substantially rectilinear vertical travel path.

2. A system according to claim 1, wherein the extensible device comprises a series of pivotally interconnected four-bar linkages, at least some of the bars of which are constituted by tubular elements for the transfer of the gaseous or liquid cargo.

3. A system according to claim 1, for a tower or column with a rotary head, wherein the said arm is carried by the said rotary head and swivels therewith into various angular positions.

4. A system according to claim 1 or claims 1 and 2, wherein the said extensible device is actuated by means, such as a cable, carried by the end of the arm and operated by a motor.

5. A system according to claim 1, with at least two articulated arms, one of which is carried by the tower head whereas the other carries the connector device, particularly through an extensible or telescopic device, wherein shock-absorbing or damping means are provided between the arms to allow the whole set of arms to follow the oscillations of sea heave while ensuring an absorbing or damping effect preventing resonance phenomena.

6. A system according to claim 5, wherein the said means are of the oleo-pneumatic type.

7. A system according to claim 1, with at least two articulated arms, one of which is carried by the tower head, whereas the other carries the connector device, particularly through an extensible or telescopic device, wherein between the arms are provided means comprising an actuator adapted to control the relative variations of the said arms.

8. A system according to claim 1, wherein shock-absorbing or damping means are provided between the vessel and the mouth-piece or fitting-head body or unit intended to receive the connector device.

9. A system according to any one of claims 1 to 8, wherein the various motors ensuring the displacements of the connector system and of the structure carrying the same are provided with relays adapted to receive radio emissions from the vessel, so that the connection operations can be controlled from the vessel.

10. A system according to any one of the preceding claims wherein said connector device is additionally connected to said head by a hawser or mooring cable.

11. A system substantially as described herein with reference to and as illustrated in the appended drawings.

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Fig.1.

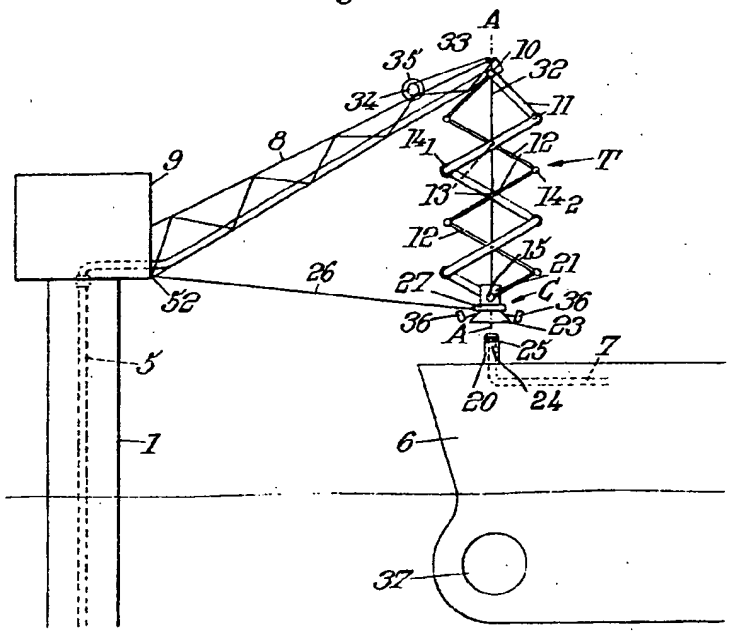

Fig.2.

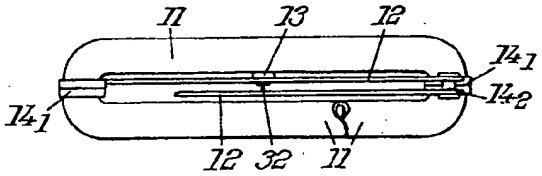

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Fig.3.